

REMARKS

Claims 1-44 are pending the present application. Claims 7-24 were previously withdrawn from consideration. Claims 1-6 are allowed. Claims 25-28 and 30-44 are rejected. Claim 29 is objected to.

The undersigned representative wishes to thank the Examiner for the allowance of Claims 1-6. Additionally, the undersigned representative would like to thank the Examiner for the indication of the allowance of Claim 29 if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The undersigned representative respectfully requests that the Examiner reconsider the rejections of Claims 25-28 and 30-44.

Rejection of Claims 25-28 and 30-36 under 35 USC § 103(a)

Claims 25-28 and 30-36 are rejected under 35 USC § 103(a) as being unpatentable over Mlcak et al. (U.S. Patent No. 5,338,416). The undersigned representative respectfully requests that the Examiner reconsider the rejections to Claims 25-28 and 30-36.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. MPEP § 2143.

The Examiner has not established a *prima facie* case of obviousness with respect to Claims 25-28 and 30-36. First, there is no hint of a suggestion or motivation to modify

Mlcak to form N-type regions, considering Mlcak focuses on etching away N-type regions. Second, there is no reasonable expectation of success since Mlcak etches away the very material that the present invention is forming. Finally, Mlcak does not teach or suggest any of the claim limitations of the present application. Each of these criteria for the *prima facie* case of obviousness are discussed in further detail below.

In the Detailed Action, the Examiner states that “Mlcak teaches either or both n and p type silicon can be selectively etched using photo-electrochemical process.” The Examiner cites Mlcak for this proposition, specifically that “either p or n type silicon can be selectively etched” (col. 1, lines 41-42) and “[t]he photo-assisted chemical machining of p and n type regions of a silicon wafer is conducted by photo-assisted electrochemical etching apparatus 10 depicted in Fig. 1.” Col. 2, lines 42-45. This proposition, however, is not relevant to the rejected claims of the present application. Claim 25, for example, recites:

25. A method for **forming an N-type contact** on an alloy-semiconductor material comprising a compound having at least a first component, the method comprising photo-electrochemical **removal of the first component to form the N-type contact**.

As illustrated by the emphasis in the claim above, the present application **forms** the N-type contact through the process of photo-electrochemical removal. In Mlcak, the photo-electrochemical etching is applied to a region of semiconductor **already having** an N-type contact. Thus, the Examiner cannot rely on Mlcak to teach or suggest forming an N-type region when Mlcak is machining, rather than forming, the N-type region.

Mlcak is not concerned with forming N-type contacts, but rather removing N-type regions of the semiconductor. The endeavor of the present application regards forming N-type and P-type regions on an alloy semiconductor. Mlcak relates to the removal of N-type

and P-type regions on a semiconductor. In the Detailed Action, the Examiner further states “Mlcak teaches that in forming various device structures, said selective etching (so-called removing in the instant claims) may be used for other semiconductor materials such as CdTe using suitable electrolytes.” Col. 7, lines 42-45. The undersigned representative agrees that Mlcak refers to the ability to etch the P and N-type regions of CdTe. Mlcak does not, however, teach or suggest the process of forming an N-type region in CdTe, as claimed in the present application.

The specification of Mlcak clearly supports the fact that Mlcak does not use etching to form N-type contacts, but rather teaches procedures for etching **pre-existing** N-type regions. In Figure 2 of Mlcak, a “wafer 14 is prepared for etching.” Col 3, line 55. On the wafer is “a pattern 62 of a p type silicon layer 18 over n type silicon 16.” Col. 3, line 57-58. Mlcak is clearly stating that the wafer has a **pre-existing** N-type region before any etching begins. At this point in the Mlcak process, no etching has occurred as Figure 2 simply depicts the preparation for etching, involving steps of forming contacts 54, 56 and a pattern 62. Col. 3, lines 55-66. Mlcak applies illumination and a voltage bias across the p-n junction to etch the N and P-type regions. Col. 4, lines 3-7. Fig. 7 depicts the wafer when “n type silicon 16 of wafer 14 has been selectively etched.” Col. 7, lines 14-15. Etched cavity 80 represents the result of etching an N-type region according to the Mlcak process. To the contrary, the result of the process of Claims 25-28 and 30-36 is the formation of an N-type contact on an alloy-semiconductor material, not the formation of a cavity. Thus, it would not be obvious to one with ordinary skill in the art to form an N-type contact on an alloy semiconductor material comprising a compound (such as CdTe) having at least a first component to form the N-type contact.

The Examiner further states that "Mlcak teaches that the method may be used to etch either n or p type material." The undersigned representative does not disagree with this statement. This statement exemplifies that Mlcak etches N-type material, instead of etching semiconductor material to form an N-type contact as set forth in the pending claims.

The Examiner further states in the Detailed Action:

Fig. 1 shows an example of depositing material and connecting the deposited material to a terminal of a power supply, connecting an electrode disposed in an electrolyte solution to a terminal of the power supply and exposing the electrolyte solution to a light source. Hence it would have been obvious to one with ordinary skill in the art to modify Fig. 1 for the proper connection in order to use said photo-electrochemical process to accommodate specific N-type or P-type material application.

The silicon wafer in Figure 1 of Mlcak, unlike the alloy semiconductor material of the present invention, already has a P-type and an N-type region. "Silicon wafer 14 is a p-on-n structure with a layer of p type silicon 19 over a region of n type silicon 16." Col. 2, lines 54-56. This silicon wafer containing the P-type and N-type regions in Figure 1 has not even been etched yet. "The silicon wafer 14 which is to be etched..." Col. 2, line 53. Thus, while Mlcak suggests the use of a photo-electrochemical process for P-type and N-type materials, Mlcak does not teach or suggest the formation of an N-type contact on an alloy-semiconductor material.

The method of forming an N-type contact is not disclosed in Mlcak. The present application, for example in Claim 25, recites in pertinent part "photo-electrochemical removal of the first component to form the N-type contact." Since Mlcak does not disclose any methods for forming an N-type contact, Mlcak cannot be used as a reference to teach the forming of an N-type contact. Mlcak disclosure on etching semiconductors does not

sufficiently teach or suggest, in combination with one of ordinary skill in the art, the method of removing a first component to form an N-type contact.

“In determining the propriety of the Patent Office case for obviousness in the first instance, it is necessary to ascertain whether or not the reference teachings would appear to be sufficient for one of ordinary skill in the relevant art having the reference before him to make the proposed substitution, combination, or other modification.” MPEP § 2143; *In re Litner*, 458 F.2d 1013, 1016, 173 USPQ 560, 562 (CCPA 1972). One of ordinary skill in the relevant art would not make the proposed modification of Mlcak to form an N-type contact on a semiconductor. Mlcak does not disclose any methods of forming an N-type contact and thus cannot possibly suggest to one of ordinary skill a novel method for doing so.

Claims 26-28 and 30-36 are dependent on Claim 25. The Examiner has rejected Claim 25 as unpatentable over Mlcak. Since the limitations of Claim 25 are necessarily incorporated into claims dependent therefrom, Claims 26-28 and 30-36 are allowable for the reasons stated herein with respect to Claim 25.

#### Rejection of Claims 37-44 under 35 USC § 103(a)

Claims 37-44 are rejected under 35 USC § 103(a) as being unpatentable over Mlcak as applied to Claims 25-28 and 30-36, and further in view of Kohl et al. (U.S. Patent No. 4,369,099).

Claims 37-41 are dependent on Claim 25. The Examiner has rejected Claim 25 as unpatentable over Mlcak. Since the limitations of Claim 25 are necessarily incorporated into

claims dependent therefrom, Claims 37-41 are allowable for the reasons stated herein with respect to Claim 25.

The Examiner repeats by reference the discussion of Mlcak from the rejection of Claims 25-28 and 30-36 under 35 USC § 103(a). As such, the undersigned representative responds similarly with the discussion provided above. Because an element of the rejected claims is not taught or suggested by the cited art, the claims are necessarily allowable. Nevertheless, the undersigned representative will explain herein the improper rejections of the remaining elements.

The Examiner has not established a *prima facie* case of obviousness with respect to Claims 37-44. First, there is no motivation to modify the references in light of the teachings disclosed herein. Second, there is not reasonable expectation of success. Finally, the combined references do not teach or suggest any claim limitations of the present application. Each of these criteria for the *prima facie* case of obviousness are discussed in further detail below.

In the Detailed Action, the Examiner states “Unlike the claimed invention, Mlcak does not teach using chemical etching for the P-type component. In a method for etching P-type semiconductor, Kohl teaches using chemical etching the P-type component.” As argued above, Mlcak does not teach or suggest photo-electrochemical removal of a portion of an alloy-semiconductor to form an N-type contact. And as admitted in the Detailed Action by the Examiner, “Mlcak does not teach using chemical etching for the P-type component.”

Claim 42 recites:

42. A method for forming a rectifying junction on an alloy-semiconductor material comprising a compound comprising a first component and a second component, the method comprising:

photo-electrochemical removal of the first component form a first portion of the alloy-semiconductor material to form an N-type contact; and  
removing the second component form a second portion of the alloy-semiconductor material to form a P-type contact.

Thus, according to Claim 42, to form an N-type contact, a first component of an alloy-semiconductor is removed through photo-electrochemical removal. Further, to form the P-type contact according to Claim 42, a second component is removed from the alloy-semiconductor material.

Kohl does not satisfy the deficiencies of this process. Kohl, does not teach or suggest providing a method for forming N-type and/or P-type contacts, through photo-electrochemical removal. The teachings of Kohl are similar to Mlcak, and for the reasons stated with regard to Mlcak are quite distinct from the pending claims. Kohl actually teaches away from the present application.

Methods of making p-type semiconductors are well known in the art. For a III-V semiconductor, a group II element (generally zinc or cadmium) is substituted for the group III element in the III-V semiconductor. Alternatively, a group IV element (generally silicon or germanium) is substituted for the group V element in the III-V compound. Typical doping levels range from  $10^{15}$  to  $10^{19}$  atoms per cubic centimeter. Similar doping schemes are used for II-VI compounds. Also, non-stoichiometric growth may provide p-type behavior.

Col. 2, lines 53-62.

Kohl is teaching that the well-known, obvious method of making a P-type semiconductor is by doping the semiconductor to substitute an element of the semiconductor. "The process of claim 1 in which the p-type semiconductor material is made by **doping** and the doping level is in the range from  $10^{15}$  to  $10^{19}$  atoms per cubic centimeter." (emphasis added) Col. 7, line 67 – col. 8, line 5. Similar to Mlcak, the method essentially involves adding a material to the semiconductor to form a P-type region.

The present application does not involve adding material, or doping the semiconductor, to form either an N-type or P-type compound. Claim 42 recites "removing the second component from a second portion of the alloy-semiconductor material to form a P-type contact." Both Mlcak and Kohl utilize a doping procedure, or the like, to add material to a semiconductor to form a P-type region. But the present invention does not add more material, and in fact, removes a component.

Kohl provides further evidence that Kohl's teaching of chemical etching the P-type component is not analogous to the present application. Figure 3 of Kohl demonstrates the results of chemical etching a P-type component.

An illustration of the versatility of the inventive process is illustrated with the aid of FIG. 3. For purposes of the illustration, assume that it is desired to make the structure shown in FIG. 3 by etching from 3 flat slabs of semiconductor material. The bottom slab is n-type semiconductor (n-sc), the middle slab is p-type compound semiconductor (p-sc') and the top layer is another p-type compound semiconductor with band gap less than the band gap of p-sc'.

Col. 6, lines 43-51.

As evidenced by Figure 3, Kohl etches to remove complete regions of a P-type semiconductor. Kohl only etches the P-type regions of the semiconductor. The etching in Kohl does not form the P-type region, but rather removes the P-type region. The Kohl disclosure, contrary to the present application, neither teaches nor suggests a method that even accomplishes the same result.

In summary, neither Mlcak nor Kohl, either alone or in combination, teach or suggest the limitations of Claims 25-28 and 30-44 of the present application. Claims 25-28 and 30-44 recite, *inter alia*, the photo-electrochemical removal of a component to form an N-type contact. Mlcak does not disclose a method for forming an N-type contact. Kohl does not

disclose a method for forming an N-type contact. The undersigned representative respectfully asserts that the pending claims are allowable over the cited art.

**Examiner's Response to Arguments**

The Examiner disagrees with the arguments proffered by the undersigned representative in the response to the second non-final Action. The Examiner states:

Applicant has argued that Mlcak does not teach using photo-electrochemical removal of a component of an alloy-semiconductor but rather etching silicon material. As has been stated in the office action, Mlcak teaches that, in forming various device structures, photo-electrochemical selectively etching (so-called removing in the instant application) may be used for other semiconductor materials such as CdTe using suitable electrolytes, see col. 7, lines 42-45. Hence, it would have been obvious to one with ordinary skill in the art to forming an N-type contact on an alloy semiconductor material.

The undersigned representative continues to advocate that Mlcak does not teach using photo-electrochemical removal of a component to form an N-type component. Mlcak utilizes photo-electrochemical removal, but not for the purpose of forming an N-type component. Mlcak's use of photo-electrochemical etching to remove semiconductor material is not analogous to the present application. Neither Mlcak nor the Examiner provide any suggestion as to why or how it would have been obvious to one with ordinary skill in the art to form an N-type contact on an alloy semiconductor material using photo-electrochemical removal.

In forming a P-type contact, the Examiner states:

Applicant has argued that claim 42 does not recite chemical etching to remove p-type material. In response, applicant recites removing the second component, which does not exclude the p-type material, and the combined prior art teaches chemical etching p-type material to form a semiconductor device, therefore, it includes forming various p-type contacts.

The Examiner is improperly generalizing phrases from the cited references and the present application. The undersigned representative asserts only that Claim 42 recites in pertinent part “removing the second component from a second portion of the alloy-semiconductor material to form a P-type contact.” Additionally, Claim 43 recites “The method according to claim 42, wherein the step of removing the second component comprises chemical etching.”

The Examiner asserts that “removing the second component” of the present application “does not exclude the p-type material.” This statement is an improper assertion.

“[R]emoving the second component” refers to removing the second component from a second portion of the alloy-semiconductor material to form a P-type contact. The alloy-semiconductor material comprises a compound comprising a first component and a second component. In effect, by removing the second component, a P-type contact is formed on the alloy-semiconductor. Thus, “removing the second component” cannot be said to exclude or include the P-type material. Instead of removing the P-type material, the present application aims to “form a P-type contact.”

The Examiner continues with the statement “the combined prior art teaches chemical etching p-type material to form a semiconductor device.” The prior art, whether singular or combined, does not etch P-type material to **form** a semiconductor device. Mlcak states “The present invention also allows three-dimensional structures to be **micromachined** with a high aspect ratio with minimal mechanical stresses because the silicon regions may be slightly doped.” (emphasis added) Col. 1, line 67 – col. 2, line 3. Kohl similarly states “[Etching procedures] are used to **alter the physical dimensions** of semiconductor material and to **cut through** semiconductor material as in cutting up semiconductor disks into individual chips.” (emphasis added) Col. 1, lines 11-14. These statements by Mlcak and Kohl evidence the fact

that they are simply shaping the semiconductor by etching the physical dimensions, rather than creating a P-type contact on the semiconductor.

The Examiner concludes the proposition with “therefore, it includes forming various p-type contacts.” As the previous clauses of the proposition are rendered incorrect, the conclusion is thus improper. The undersigned representative directs the Examiner to the discussion herein of “creating a P-type contact” under the sub-heading “Rejection of Claims 37-44 under 35 USC § 103(a).”

CONCLUSION

In light of the above remarks, it is respectfully submitted that the application is now in condition for allowance. Early notification of issuance is earnestly requested. Should the Examiner determine that any further action is necessary to place this application into better form, he is encouraged to telephone the Applicants' undersigned representative at the number listed below.

Respectfully submitted,

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